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(71) Applicant *(for all designated States except US)*: MEKRAP-ID [FI/FI]; Industrivägen 11, SF-68600 Jakobstad (FI).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)* : KJELLMAN, Fredrik [FI/FI]; Bojvägen 6, SF-68620 Jakobstad (FI).

(74) Agent: OY JALO ANT-WUORINEN AB; Skepparebrinken 2 A, SF-00120 Helsingfors (FI).

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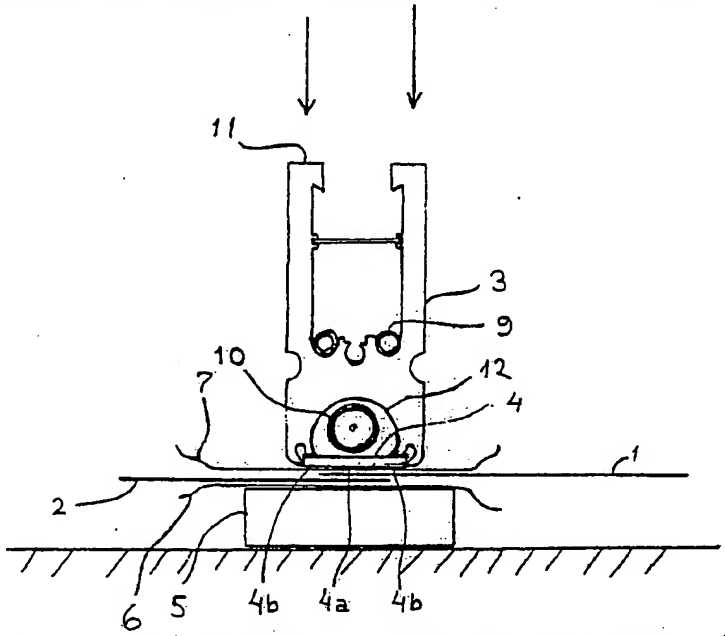

(57) Abstract

The present invention concerns a method and a device for joining together of thermoplastic materials (1, 2) by keeping these fixed against one another between a transparent contact face (4) and a counter-piece (5) and by exposing the thermoplastic materials (1, 2) through the contact face (4) to IR light until at least the pre-melting temperature of the thermoplastic materials (1, 2) is reached in the area of the joint. The invention is characterized in that the exposing takes place only through a limited area (4a) of the contact face, which said area (4a) is arranged to shape the face of the joint both during the exposure and during the subsequent cooling, whereas the surrounding parts of the contact face (4) constitute a combined support and fixing portion (4b) for the contact face (4) and for the thermoplastic materials (1, 2).

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Method and device for joining together of thermoplastic materials

The present invention concerns a method and a device for joining together of thermoplastic materials by keeping these fixed against one another between a transparent contact face and a counter-piece and by exposing the thermoplastic materials through the contact face to IR light until at least the pre-melting temperature of the thermoplastic materials is reached in the area of the joint.

In prior art, it has not been possible to use the same equipment for the joining together of thermoplastics of different types. For example, for polyethylene mainly the joining together by means of heated welding jaws or by means of resistance wires and partly also blowing of warm air have been employed, whereas, e.g., for PVC plastic mainly high-frequency welding is employed.

It is a drawback of all of these prior-art modes of joining together that in the joint itself the thermoplastic material is subjected to an extremely severe treatment so that it obtains altered properties at the same time as fractural impressions are readily formed in the plastic material right next to the joint.

In joining by means of heated welding jaws, problems often arise therein that molten plastic material adheres to the jaws, which deteriorates both the appearance and the quality of the joints decisively. Attempts have been made to eliminate this problem partly by coating the faces of the welding jaws with silicone, but then the silicone again affects the plastic material itself and deteriorates the welding result.

In the case of joining together by means of resistance wires, an intensive heating of the plastic material takes place in an extremely limited area, at the same time as the shape of the resistance wires itself acts upon the face of the joint, which results in fractural impressions to an increased extent and makes the joint itself less attractive. Moreover, the prior-art modes of joining often require that heating takes place from both sides.

Joining together by means of high-frequency technique requires a highly complicated and expensive equipment.

The prior-art methods of joining together cause problems in stepwise preparation of long joints and are, as a rule, not at all suitable for joining together of coextruded or glued laminates. The intensive phase of heating, viz., readily damages the plastic material, e.g. in the portions in the joint where the zones of heating overlap each other. It is a further drawback of all of the earlier methods that they require an absolutely uniform distribution of the pressure across the entire area wherein the joint is to be produced in order that a uniform joint could be obtained.

From the British Patent Application No. 2,103,147 a method and a device are known for joining together of two thermoplastic materials of which at least one is provided with a light-absorbing layer. The device comprises a hood with a transparent window on one side and with reflecting inner wall faces at the other sides, a tungsten-halogen source of light within the hood, and means for relative adjustment of the source of light and of the thermoplastic film so that the radiation penetrates through the light-transmitting layer in one of the thermoplastic materials and melts its light-absorbing layer at the other thermoplastic material, and means for pressing together the two thermoplastic materials during the radiation. In the text it is stated that this method can only be used for

joining together of two thermoplastic materials provided that one of the thermoplastic materials absorbs light or is provided with a light-absorbing layer. Two completely transparent thermoplastic materials cannot be joined together by means of the method of said GB application, and no solution is given for the production of a long continuous joint.

The object of the present invention is to eliminate all of the above problems, which is achieved thereby that the exposing takes place only through a limited area of the contact face, which said area is arranged to shape the face of the joint both during the exposure and during the subsequent cooling, whereas the surrounding parts of the contact face constitute a combined support and fixing portion for the contact face and for the thermoplastic materials.

According to the invention, joints are obtained in a both simple and reliable way, which said joints have strength, reliability, appearance and shape far superior to all of the prior-art types of joints. As the part of exposure in the contact face is surrounded by a combined support and fixing part wherein no exposure to IR light takes place, it is ensured that during the process of joining together the thermoplastic material maintains its thickness in the joint in spite of the fact that during the phase of exposure the thermoplastic material is converted to molten state in the portions that are exposed.

The further characteristics of the invention come out from the accompanying patent claims. In the following, the invention will be described in more detail with reference to the accompanying drawing, wherein

Fig. 1 is a perspective view of an exemplifying embodiment of a tool in accordance with the invention,

Fig. 2 shows an example of the joining together of two thermoplastic films in accordance with the invention,

Fig. 3 is a schematical perspective view of the joining of a corner in accordance with the invention,

Fig. 4 shows the same as seen from above, and

Fig. 5 shows another example of the joining of a corner, seen from above.

In joining together of thermoplastic materials 1, 2, such as polyethylene, PVC, polystyrene, polypropylene, and coextruded or glued laminates of varying thicknesses, from the thinnest films of about 0.005 mm to thick board materials of more than 16 mm, the thermoplastic materials 1, 2 to be joined together are pressed against one another by means of a transparent contact face 4 of a tool 3 and exposed through the contact face 4 to IR light until at least the pre-melting temperature of the thermoplastic materials 1, 2 is reached in the area of the joint, whereby the area 4a of the contact face 4 through which the exposure takes place is arranged to shape the face of the joint both during the exposure and after the subsequent cooling, whereas the surrounding parts of the contact face 4 constitute a combined support and fixing part 4b for the area 4a and for the thermoplastic materials 1, 2. The number of the thermoplastic materials 1, 2 to be joined together may be two or higher, and they may be arranged either so that they overlap each other in the joint, as comes out from Fig. 2, or so that they are joined end against end (butt weld). Depending on the thermoplastic material concerned and on its thickness, the time of exposure may vary from about 0.1 second up to several minutes. As the thermoplastic materials placed under the lateral areas 4b of the contact face are not exposed, these constitute an excellent support for the tool 3 during the working phase in which the plastic

material is in molten state, and thereby ensure that the thickness of the thermoplastic materials in the joint area itself remains unchanged. At the exposure, preferably a somewhat elastic counter-piece 5 is used, preferably provided with a heat-resistant face, against which the thermoplastic materials 1, 2 are pressed by means of the contact face 4 of the tool.

If the thermoplastic material or materials 1, 2 is/are fully transparent and colourless, the IR light passes through without heating them. The same is, of course, true regarding the transparent contact face 4. In order that heating of the thermoplastic materials should then take place, it is possible either to use an IR-light-absorbing, preferably black counter-piece 5 or to place an IR-light-absorbing insulation layer, e.g. a black teflon tape 6, on the counter-piece, whereby the counter-piece 5 or the insulation layer 6 is heated and, in its turn, heats the thermoplastic materials 1, 2. If it is desirable to distribute the heating so that part of the heat comes from the top side and part of it from the bottom side, on the counter-piece 5, underneath the thermoplastic material 2, it is possible to place a black teflon tape 6, and above the thermoplastic material 1 a teflon tape 7 which is partly transparent but has a certain ability to absorb IR light.

Another possibility in the joining together of transparent or white films is to place a narrow IR-light-absorbing strip of thermoplastic film either between or at one side of the thermoplastic materials along the line at which the joint is to be formed. Thereby the black strip is heated, and together with it also the surrounding transparent, colourless or white plastic materials 1, 2, to the desired pre-melting temperature, whereby a joining together takes place between all of the thermoplastic materials in the area of exposure. Thus, the joint formed also includes the IR-light-absorbing thermoplastic strip.

When transparent films 1, 2 are being joined together, it is possible to obtain the desired shape and extension of the joint if a counter-piece 5 is used which is transparent or provided with a mirror face and if an IR-light-absorbing, preferably black strip of heat-resistant material is placed in the desired location underneath the thermoplastic materials, which said strip has the shape that is desired for the joint. During exposure, only the strip is heated and, by its effect, only the portions of the thermoplastic materials that are in contact with the strip, for which reason the strip determines the contours of the joint.

If it is desirable to obtain a joint that can be opened without the plastic material itself being torn to pieces, i.e. in the case of various consumer packages, extremely short times of exposure must be used.

When goods are wrapped, the method in accordance with the present invention can be employed as replacement for packaging by means of shrink film, with remarkable economies of energy as a result. The thermoplastic film is first tightened around the goods or object to be wrapped with the aid of a suitable tightening means, either so that both ends of the film passed around the goods are pulled through glide discharge devices to a projecting crank between the contact face 4 of the exposure tool 3 and the counter-piece 5, or so that, before tightening, one end of the film is fixed to the object in a suitable way, whereby the tightening takes place as parallel to one of the sides of the object, which said side, in this case, acts as the counter-piece. When the exposure tool is thereupon pressed against the counter-piece or against the side of the object, respectively, the film is kept fixed in the tightened state during the exposure and cooling, so that an extremely strong and solid package is obtained. When the exposure does not take place right up to the edges of the contact face, a secure fixing of the film is obtained during exposure and cooling, in spite of

the fact that in the exposure area itself the thermoplastic material is converted to molten or almost molten state.

Depending on the ratio between the joint length and the tool length, the joining together may take place as one step, stepwise, or continuously.

In joining together of coextruded or laminated films with, e.g., colourless layers at one side and with an IR-light-absorbing, e.g. black, layer at the other side, the joining together can take place advantageously so that the IR-light-absorbing sides are turned against one another and the exposure takes place from one side through the transparent layer or layers, which remains/remain unaffected by the heating at the same time as the joining together of the IR-light-absorbing layers takes place. The best result is obtained if the melting temperature of the transparent layers is higher than that of the IR-light-absorbing layers, whereby the joint becomes substantially unnoticeable from outside.

In the case of overlapping joining between a transparent film and a strongly coloured film, the best results are obtained if the exposure takes place from the side of the transparent film.

In the case of continuous joining together, the tool is moved under application of a pressure to the thermoplastic materials along the line in which the joint is supposed to be formed. If the tool is of an oblong type, by means of this method it is also possible to achieve lamination of two or possibly even more thermoplastic materials by moving the tool in its transverse direction across the plastic materials.

In joining together of thick board materials of strongly coloured thermoplastic, an excellent joint end against end is obtained if both of the joint faces are chamfered

so that a V-shaped groove is formed between the two boards and a transparent V-section thermoplastic material is placed in the groove, whereby the exposure of the slanting faces of the two board materials takes place through the transparent additional material.

In joining of a thermoplastic material, such as polypropylene, to a box-shaped construction it is possible to do, e.g., so that the sides A and B of a ready-cut box blank are folded up into contact with a counter-piece 5 that has the shape of a corner, said counter-piece 5 being appropriately provided with a dark teflon insulation 6, whereupon the edges of the side walls A, B are kept pressed against one another, supported by the counter-piece 5, by means of the contact face 4 of the tool, whereupon the exposure of the joint portion to IR light takes place from outside, substantially in the diagonal direction. In order to limit the area that is to be exposed, it is possible to use some sort of shields or templets 8. As the contact face 4, it is possible to use, e.g., a flexible teflon tape or silicone rubber cloth, which is, at the exposure and cooling phase, tightened against the corner by means of forces acting in the directions of the side walls A, B, as comes out from Fig. 3. Another possibility is to press an angular face of a transparent solid material, such as glass, against the corner portion in diagonal direction, as comes out from Fig. 5.

In particular in the case of continuous joining, but also in the case of stepwise joining if long exposure times are employed, a need arises to have more efficient cooling both of the tools and of the thermoplastic materials, in particular if a more rapid working cycle is desired. The cooling can be achieved in a simple way by means of a cooling medium in the form of a gas or liquid, said medium being passed through cooling ducts 9 formed for the purpose into the tool 3.

Cooling can also be arranged so that, when full exposure time is reached, the cooling medium is pressed in between the contact face 4 of the tool and the thermoplastic film 1, e.g., in a transparent flexible hose, which is applied across the contact face 4 and is completely flattened during the exposure, but into which an increased inner pressure is introduced at the beginning of the cooling phase. Moreover, if the cooling medium is coloured, by means of this procedure, at the same time, a shutter is obtained which prevents radiation from the as yet glowing source 10 of IR radiation from penetrating up to the thermoplastic material, which accelerates the cooling further.

By means of the method in accordance with the invention, an arbitrary number of thermoplastic films can be joined together, whereby the joint that is formed has a throughout excellent quality irrespective of the number of films.

A further mode of obtaining the desired contours of the joint is to place a templet between the tool and the thermoplastic film, said templet having a slot or opening of desired shape and dimension, whereby the exposure takes place exclusively through said slot or opening. The opening may be shaped, e.g., as a text or some other information.

In view of fine adjustment of the tool so that the best possible result should be obtained for the thermoplastic material that is to be joined in the particular case, it is possible to vary the wavelength of the IR light.

The method may also be used in the filing of documents or equivalent, in which case a text or a figure, such as a coat-of-arms or a seal, is printed in the joint, having been engraved in the area of exposure 4a of the contact face 4 of the tool. Another possibility is to bake a band with a text or figure into the joint.

As comes out from the above, the device in accordance with the invention comprises a transparent contact face 4 and a counter-piece 5 jointly operative with the contact face for fixing of the thermoplastic materials 1, 2, as well as a source 10 of IR light for exposure of the thermoplastic materials 1, 2 through the contact face 4. The contact face 4 is provided with a central exposure portion 4a and with a shielded support and fixing portion 4b which surrounds the exposure portion. The device may be designed as a hand tool 3, in which case it is provided with an operating handle at its side directed away from the contact face 4, or as a tool 3 fitted in a welding or joining machine, in which case its "back side" is appropriately provided with a fixing rail 11 of the dovetail type. The source 10 of IR light may be spherical, tubular, or possibly only consist of a filament which is capable of emitting IR light. In the latter two cases the frame of the tool 3 appropriately consists of an aluminium profile, e.g. in accordance with Figures 1 and 2. In order to avoid adhering of molten thermoplastic material to the contact face 4, the latter is appropriately coated with silicone or teflon.

In view of intensifying the IR-light radiation, the source 10 of IR light may be appropriately provided with a separate or integrated reflector 12. Further intensification is obtained if the hood of the source 10 of IR light or the exposure portion 4a of the contact face 4 is shaped as focusing.

The contact face 4 of the tool may consist of a plane, preferably heat-resistant glass plate, of a glass prism with a considerably larger dimension in the direction of the beam than in its cross direction as well as with a trapezoidal or rectangular section, of a silicone rubber body of corresponding format, of a flexible, transparent heat-resistant film or a transparent solid body with a shape suitable for some particular purpose, such as a

glass body bent at an angle, e.g. as is shown in Fig. 5. The prismatic form mentioned above is applied, e.g., when joining takes place in an extremely limited space.

For the purpose of cooling, the tool may be provided with cooling ducts 9, e.g., inside the body of the tool, or it may be provided with a flexible hose applied across the contact face 4, the circumference of said hose being considerably larger than the twofold width of the contact face 4. Hereby a part of the hose projects out to the side of the tool, which said part can contain cooling medium during the exposure phase and from which said part the cooling medium can be pressed during the subsequent cooling phase in a simple way into the space between the contact face 4 and the thermoplastic film 1 without affecting the pressure against the thermoplastic film.

In view of accelerating the working cycle, the tool may be appropriately provided with a mechanical shade or shutter which is arranged to close the exposure opening immediately after the preset exposure time has elapsed.

As a rule, the best distribution of pressure is obtained across the joint if the counter-piece 5 consists of a plane, somewhat elastic cushion, but in certain cases a completely hard counter-piece may be preferable.

If it is desirable to obtain a distribution of the heating so that it takes place partly from the top side of the films and partly from the bottom side, next to the contact face 4 it is possible to choose a teflon tape 7 with a desired degree of IR-light absorption capacity.

By applying the reflector 12 directly onto the glass hood of the source 10 of IR light, at the same time as the hood is rotatable in the axial direction in the frame of the tool 3, a possibility of simple regulation of the intensity of the exposure is obtained. At the same time,

an efficient shutter is obtained when the source of light is rotated so that the part of the glass hood on which the reflector face 10 is fitted is turned towards the contact face 4.

In order to obtain a flexible contact face 4, the tubular source 10 of IR light may be possibly fixed to the inside of a transparent flexible silicone hose, which can be pressure-loaded during exposure and cooling as necessary.

The tool may also be provided with two or more contact faces so that several joints can be prepared at the same time. In such a case, the contact faces 4 may be placed at adjoining sides or at opposite sides of the tool 3.

In the case of continuous joining together, it may be advantageous to have a contact face in the form of an endless band of transparent teflon tape which is freely rotatable around guide rolls fitted at the end portions of the tool. In the case of continuous joining together, a spherical source of IR light may be preferable in certain cases.

The most advantageous mode of producing a continuous joint along an arbitrary path in accordance with the present invention is to press the thermoplastic materials to be joined together in the desired position between a counter-piece and a large stationary contact face so that the thermoplastic materials are pressed together over the entire area where the joint is to be produced, together with the adjoining portions at both sides of the joint, and to pass the source of IR light together with the related reflectors, which are arranged both to concentrate and to shield the beams of IR light so that the exposure takes place only at a point or along a line of a width corresponding to the width of the desired joint, which said source of IR light is arranged to be passed along an arbitrary path at a predetermined distance from the contact

face. If a large series of joints with the same shape are to be produced, the source of IR light and the related reflectors may be arranged displaceable along a guide of the same shape as the shape of the desired joint.

True enough, the tool may also be provided with several sources of IR light focused to the same point, or several tools 3 may be connected as a panel, in which case further cooling ducts may be provided between the tools, as is implied in the section shown in Fig. 2.

WHAT IS CLAIMED IS:

1. Method for joining together of thermoplastic materials (1,2) by keeping these fixed against one another between a transparent contact face (4) and a counter-piece (5) and by exposing the thermoplastic materials (1,2) through the contact face (4) to IR light until at least the pre-melting temperature of the thermoplastic materials (1,2) is reached in the area of the joint, c h a r a c t e r - i z e d in that the exposing takes place only through a limited area (4a) of the contact face (4), which said area (4a) is arranged to shape the face of the joint both during the exposure and during the subsequent cooling, whereas the surrounding parts of the contact face (4) constitute a combined support and fixing portion (4b) for the contact face (4) and for the thermoplastic materials (1,2).

2. Method as claimed in claim 1, c h a r a c t e r - i z e d in that the thermoplastic materials (1,2), whose number is two or more, overlap each other at the place of joining together.

3. Method as claimed in claim 1, c h a r a c t e r - i z e d in that two thermoplastic materials are joined together end to end.

4. Method as claimed in claim 1, c h a r a c t e r - i z e d in that, when two transparent or white thermoplastic materials (1,2) are joined together, before the exposure an IR-light-absorbing thermoplastic strip is placed under or between the thermoplastic materials (1,2).

5. Method as claimed in any of the claims 2 to 4, c h a r a c t e r i z e d in that the counter-piece (5) is provided with an elastic, preferably heat-resistant face.

6. Method as claimed in claim 5, c h a r a c t e r - i z e d in that, when transparent thermoplastic materials (1,2) are joined together, an IR-light-absorbing, preferably black, counter-piece (5) is used.

7. Method as claimed in claim 5, c h a r a c t e r - i z e d in that, when transparent thermoplastic materials (1,2) are joined together, a substantially transparent counter-piece (5) or a counter-piece (5) provided with a mirror face is used, on which a narrow, IR-light-absorbing, preferably black heat-resistant band with desired contours is placed.

8. Method as claimed in any of the preceding claims, c h a r a c t e r i z e d in that, in connection with wrapping, a film-shaped thermoplastic material is tightened around an object to be wrapped and kept fixed by means of the tool (3) in a projecting crank during exposure and cooling.

9. Method as claimed in any of the claims 1 to 8, c h a r a c t e r i z e d in that, in connection with wrapping, a film-shaped thermoplastic material is tightened around an object to be wrapped, whereby one end of the film is, before the tightening, fixed to the object and the object itself is used as a counter-piece during the exposure and cooling.

10. Method as claimed in any of the preceding claims, c h a r a c t e r i z e d in that the joining together is performed continuously.

11. Method as claimed in any of the claims 1 to 9, c h a r a c t e r i z e d in that the joining together takes place stepwise.

12. Method as claimed in claim 10 or 11, c h a r a c - t e r i z e d in that in overlapping-joining of two

coextruded or laminated thermoplastic materials so that transparent layers are placed at the sides directed away from each other and IR-light-absorbing layers are placed at the sides placed against one another, an efficient joining together is obtained between the IR-light-absorbing layers whereas the transparent layers remain completely unaffected.

13. Method as claimed in claim 10 or 11, c h a r a c t e r i z e d in that in overlapping-joining of a transparent film and a strongly coloured film, the exposing takes place preferably from the side of the transparent film.

14. Method as claimed in claim 5, c h a r a c t e r i z e d in that in joining of thermoplastic material to a box-shaped construction wherein the joining together takes place along the edges of the box, the edges of the side walls (A,B) are pressed against one another under support of a counter-piece (5) of appropriate form, whereby the exposure takes place from the outside, substantially in a diagonal direction through a contact face (4) of a flexible material or of a material of permanent shape.

15. Method as claimed in any of the claims 1 to 14, c h a r a c t e r i z e d in that the cooling of the thermoplastic materials that were joined together takes place by means of a preferably coloured cooling medium, which is, at the beginning of the cooling, pressed into a transparent flexible hose fitted between the contact face (4) and the topmost thermoplastic material (4).

16. Method as claimed in any of the preceding claims, c h a r a c t e r i z e d in that between the contact face (4) and the thermoplastic film (1), a templet is placed which is provided with an opening of desired shape and dimension.

17. Method as claimed in claim 16, c h a r a c t e r - i z e d in that the opening is shaped as a text or as other information.

18. Method as claimed in any of the claims 1 to 16, c h a r a c t e r i z e d in that into the joint a text or a figure is printed, which is engraved in the exposure portion (4a) of the contact face (4).

19. Method as claimed in any of the claims 1 to 19, c h a r a c t e r i z e d in that a band with a text or a figure is baked into the joint.

20. Device for joining together of thermoplastic materials, comprising a transparent contact face (4) and a counter-piece (5) jointly operative with the contact face for fixing of the thermoplastic materials (1,2), as well as a source (10) of IR light for exposure of the thermoplastic materials (1,2) through the contact face (4), c h a r a c t e r i z e d in that the contact face (4) is provided with a central exposure portion (4a) and with a shielded support and fixing portion (4b) which surrounds the exposure portion (4a).

21. Device as claimed in claim 20, c h a r a c t e r - i z e d in that the contact face (4) is coated with silicone or teflon.

22. Device as claimed in claim 20 or 21, c h a r a c - t e r i z e d in that the source (10) of IR light is provided with a separate or integrated reflector (12).

23. Device as claimed in claim 22, c h a r a c t e r - i z e d in that the hood of the source (10) of IR light or the exposure portion (4a) of the contact face (4) has been shaped as focusing.

24. Device as claimed in any of the claims 20 to 23,

c h a r a c t e r i z e d in that the contact face (4) consists of a plane, heat-resistant glass plate.

25. Device as claimed in any of the claims 20 to 24, c h a r a c t e r i z e d in that the contact face (4) consists of a glass prism of trapezoidal or rectangular section, whose dimension in the direction of the beam is considerably larger than its dimension in the transverse direction of the prism.

26. Device as claimed in any of the claims 20 to 24, c h a r a c t e r i z e d in that the contact face (4) consists of a flexible heat-resistant film of teflon tape or silicone rubber.

27. Device as claimed in any of the claims 20 to 26, c h a r a c t e r i z e d in that a transparent and flexible hose is fixed across the contact face (4) and has a circumference which is considerably larger than the twofold width of the contact face (4).

28. Device as claimed in any of the claims 20 to 27, c h a r a c t e r i z e d in that the device is provided with a mechanical shutter.

29. Device as claimed in any of the claims 20 to 24, c h a r a c t e r i z e d in that the counter-piece (5) consists of an elastic, plane cushion.

30. Device as claimed in any of the claims 20 to 24, c h a r a c t e r i z e d in that the counter-piece (5) is hard.

31. Device as claimed in claim 29 or 30, c h a r a c - t e r i z e d in that the counter-piece (5) is provided with an IR-light-absorbing and thermally insulating face.

32. Device as claimed in claim 29 or 30, c h a r a c -

t e r i z e d in that the counter-face (5) is transparent or is provided with a mirror face.

33. Device as claimed in any of the claims 20 to 32, c h a r a c t e r i z e d in that between the thermoplastic material (2) and the counter-piece (5) as well as between the thermoplastic material (1) and the contact face (4), teflon layers (6, 7) of different degrees of transparency are placed.

34. Device as claimed in claim 22, c h a r a c t e r i z e d in that the reflector (12) is applied directly onto the side wall of the tubular source (10) of IR light, and the source (10) of IR light is fitted axially rotatably in a tool (9).

35. Device as claimed in claim 22, c h a r a c t e r i z e d in that the tubular source (10) of IR light is fixed at the side wall inside a transparent flexible silicone hose, which can be pressure-loaded during exposure and cooling as necessary.

36. Device as claimed in claim 22, c h a r a c t e r i z e d in that the transparent contact face (4) consists of a freely rotatable endless band of teflon tape or silicone rubber passing over guide rolls.

37. Device as claimed in claim 22, c h a r a c t e r i z e d in that the contact face is stationary and the source (10) of IR light with the related reflectors (12) is freely displaceable along an arbitrary path at a predetermined distance from the contact face (4).

38. Device as claimed in claim 22, c h a r a c t e r i z e d in that the device is shaped as a tool (3) in whose frame the source (10) of IR light, the reflector (12), the contact face (4) and possibly cooling ducts (9) are mounted.

AMENDED CLAIMS
[received by the International Bureau on 9 October 1989 (09.10.89)
original claim 1 amended; other claims unchanged (1 page)]

1. Method for joining together of thermoplastic materials (1,2) by keeping these fixed against one another between a transparent contact face (4) and a counter-piece (5) and by exposing the thermoplastic materials (1,2) through the contact face (4) to IR light until at least the pre-melting temperature of the thermoplastic materials (1,2) is reached in the area of the joint, which exposing takes place only through a limited area (4a) of the contact face (4), which said area (4a) is arranged to shape the face of the joint both during the exposure and during the subsequent cooling, c h a r a c t e r i z e d in that the surrounding parts of the contact face (4) constitute a combined support and fixing portion (4b) for the contact face (4) and for the thermoplastic materials (1,2).

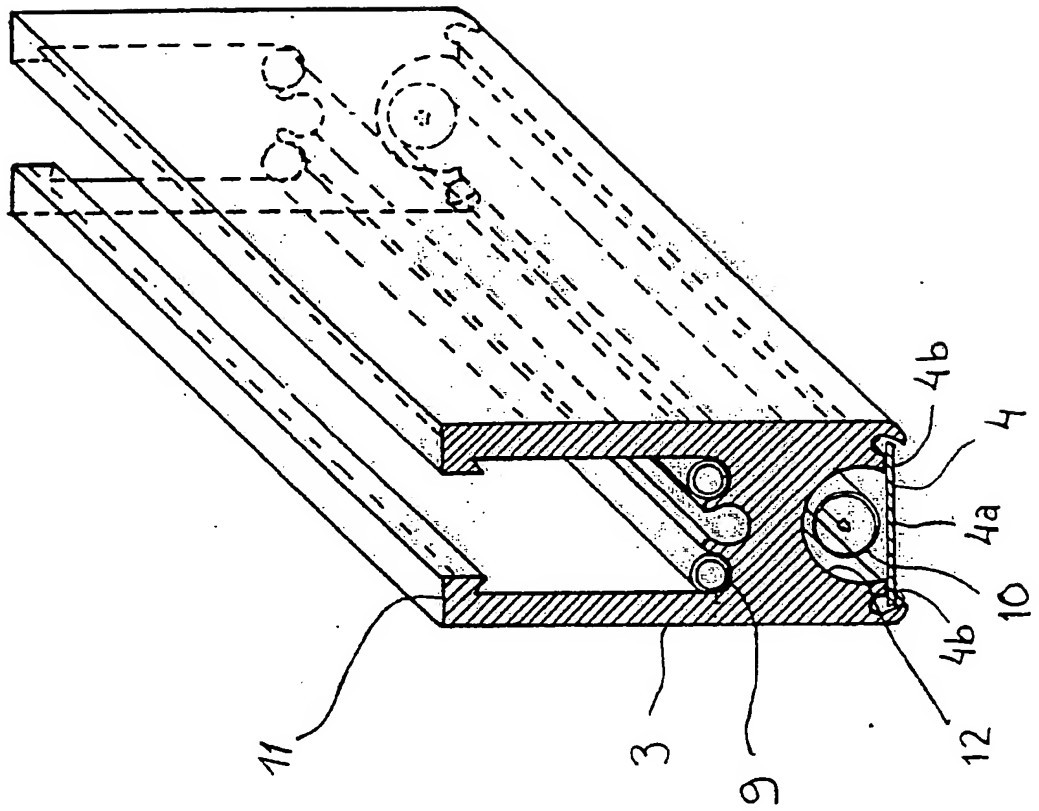
2. Method as claimed in claim 1, c h a r a c t e r i z e d in that the thermoplastic materials (1,2), whose number is two or more, overlap each other at the place of joining together.

3. Method as claimed in claim 1, c h a r a c t e r i z e d in that two thermoplastic materials are joined together end to end.

4. Method as claimed in claim 1, c h a r a c t e r i z e d in that, when two transparent or white thermoplastic materials (1,2) are joined together, before the exposure an IR-light-absorbing thermoplastic strip is placed under or between the thermoplastic materials (1,2).

5. Method as claimed in any of the claims 2 to 4, c h a r a c t e r i z e d in that the counter-piece (5) is provided with an elastic, preferably heat-resistant face.

Fig. 1.



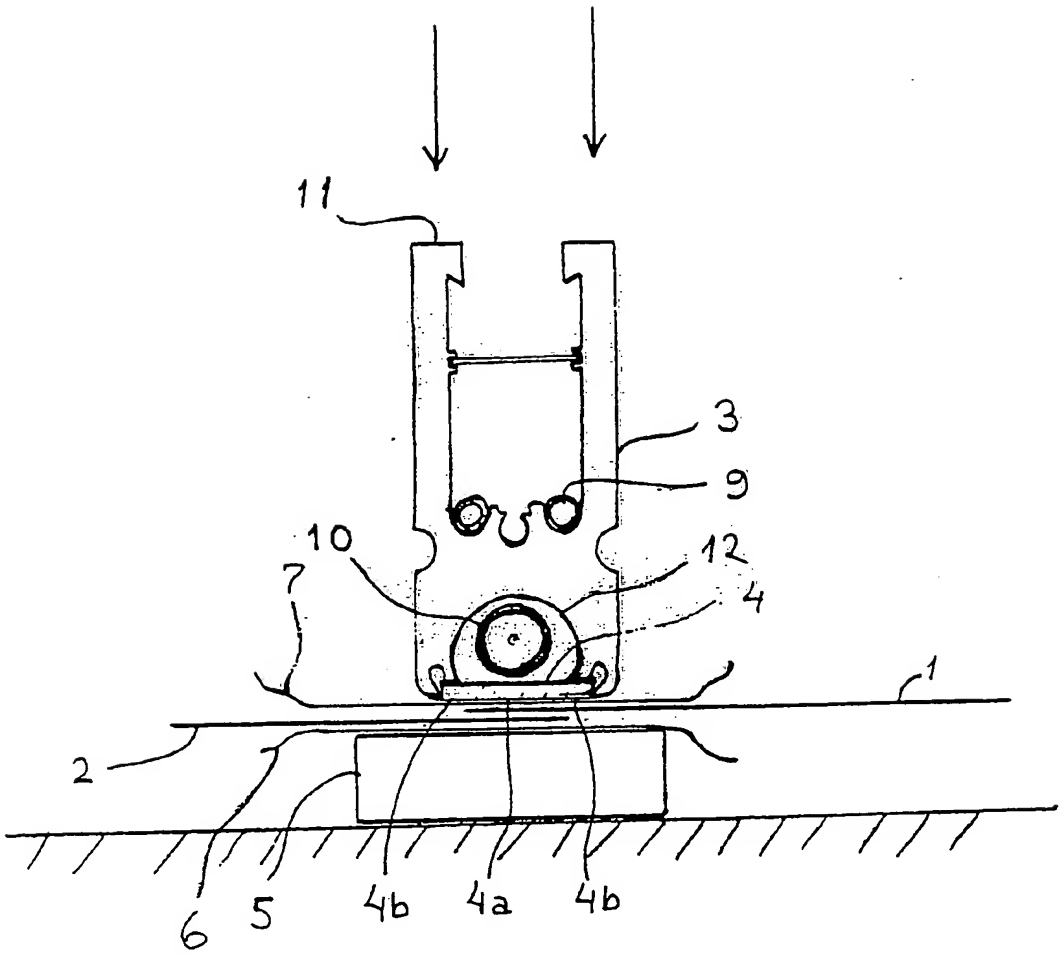


Fig. 2

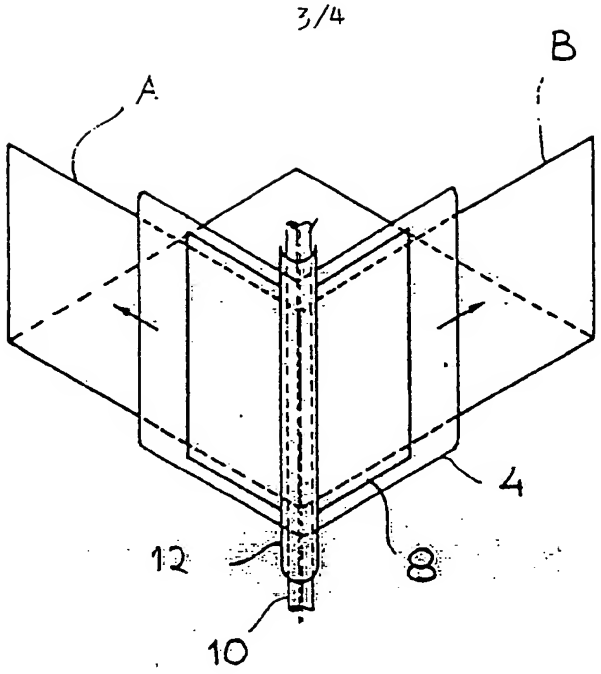


Fig. 3

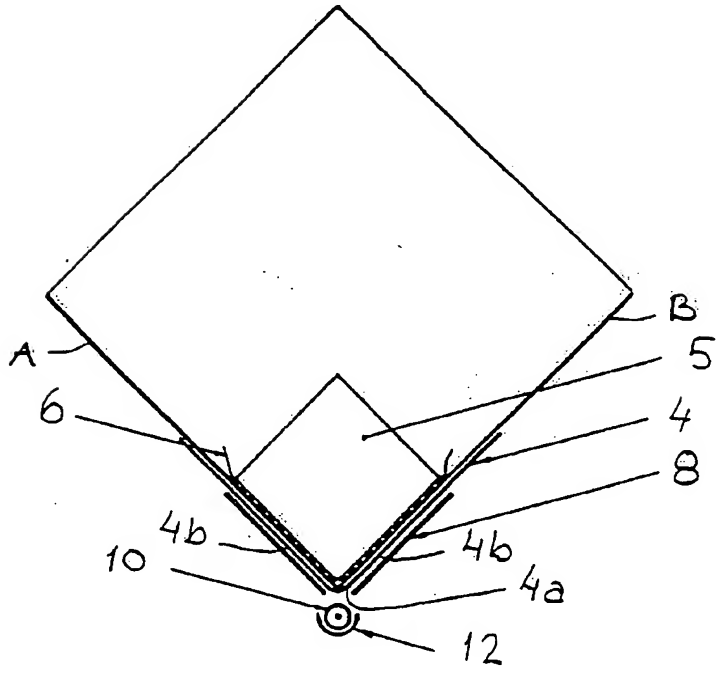


Fig. 4

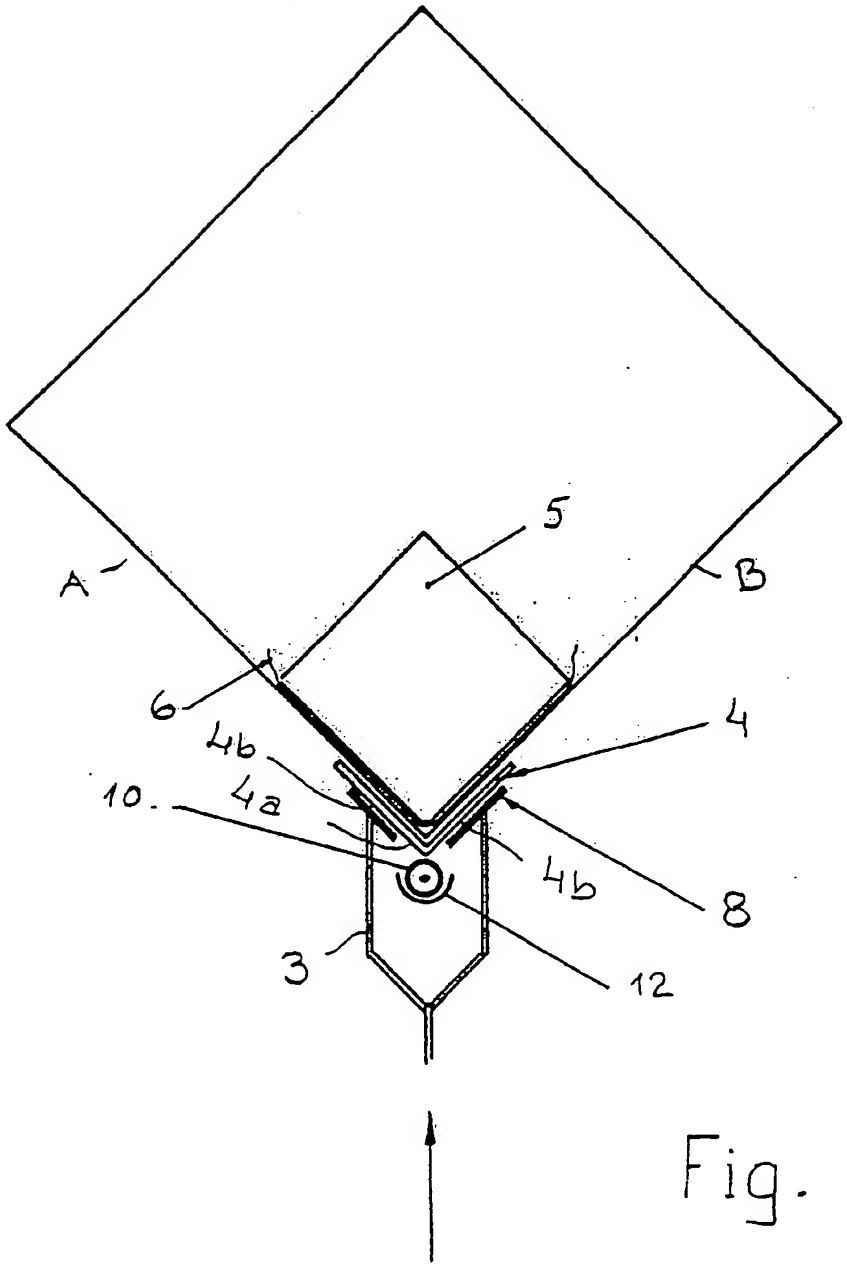


Fig. 5

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI89/00085

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

B 29 C 65/14

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	B 29 C

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	DE, A, 1 779 603 (RÖVER ET AL) 23 September 1971 & FR, 2062913 whole document	1-6, 10, 11, 15, 20-24, 26, 28-32, 34, 36-38
Y		7, 12, 33
X	US, A, 3 247 041 (W.E. HENDERSON) 19 April 1966 whole document	1-7, 10, 11, 13-16, 19, 20-23, 26, 28-31, 34, 36-38
Y		8, 12, 24, 32, 33
Y	US, A, 3 384 526 (A.E. ABRAMSON ET AL) 21 May 1968 col 2 line 63 - col 3 line 5, col 3 line 62 - col 4 line 26, col 5 lines 36-65, claims	1-7, 10, 11, 13-19, 20-24, 26, 28-32, 34, 36-38

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1989-08-16	1989 -08- 21
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	Jan Nilsson

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
Y	DE, A1, 2 749 202 (ZENTRALINSTITUT FÜR SCHWEISSTECHNIK DER DDR) 8 June 1978 whole document	1-3, 5, 20-24, 26, 29, 30, 36-38
Y	Derwent's abstract No. 84 016226/03, SU 1004 127	4, 10-12, 33
Y	GB, A, 2 065 025 (NORDSON CORPORATION) 24 June 1981 especially abstract & FR, 2466397 DE, 3036527 JP, 56057612 US, 4319443 AUD, 61408/80	8
A	SE, B, 415 080 (O.E. GUSTAVSSON) 8 September 1980 whole document	1, 20
A	GB, A, 2 103 147 (PA MANAGEMENT CONSULTANTS LIMITED) 16 February 1983 whole document	1, 20
A	US, A, 3 804 691 (TRIVEDI) 16 April 1974 whole document	1, 20